

Many Patients Who Undergo Surgery for Colorectal Cancer Receive Surveillance Colonoscopies Earlier Than Recommended by Guidelines

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See editorial on page 79.

BACKGROUND & AIMS: Patients treated with surgery for colorectal cancer (CRC) should undergo colonoscopy examinations 1, 4, and 9 years later, to check for cancer recurrence. We investigated the use patterns of surveillance colonoscopies among Medicare patients. **METHODS:** We used the Surveillance, Epidemiology and End Results (SEER)–Medicare linked database to identify patients who underwent curative surgery for colorectal cancer from 1992 to 2005 and analyzed the timing of the first 3 colonoscopies after surgery. Early surveillance colonoscopy was defined as a colonoscopy, for no reason other than surveillance, within 3 months to 2 years after a colonoscopy examination with normal results. **RESULTS:** Approximately 32.1% and 27.3% of patients with normal results from their first and second colonoscopies, respectively, underwent subsequent surveillance colonoscopies within 2 years (earlier than recommended). Of patients who were older than 80 years at their first colonoscopy, 23.6% underwent a repeat procedure within 2 years for no clear indication. In multivariable analysis, early surveillance colonoscopy was not associated with sex, race, or patients' level of education. There was significant regional variation in early surveillance colonoscopies among the Surveillance, Epidemiology, and End Results regions. There was a significant trend toward reduced occurrence of second early surveillance colonoscopies. **CONCLUSIONS: Many Medicare enrollees who have undergone curative resection for colorectal cancer undergo surveillance colonoscopy more frequently than recommended by the guidelines. Reducing overuse could free limited resources for appropriate colonoscopy examinations of inadequately screened populations.**

Keywords: Prevention; Early Detection; Colon Cancer Screening; Cost Efficacy.

Colorectal cancer is the third most common cancer in the United States. In 2012, an estimated 143,460 patients will be diagnosed with colorectal cancer.¹ In 76% of these patients, the disease will be either localized or extending to the regional lymph nodes, qualifying them for curative resection.^{2,3} Approximately 30% to 40% of patients will develop recurrent colorectal cancer after curative surgery.^{2,4,5} Studies show that surveillance colonoscopy identifies early recurrences at a stage that allows curative treatment.^{6–11} Hence, the American Cancer Society, American Gastroenterology Association, and the US Multi-Society Task Force on Colorectal Cancer all recommend surveillance colonoscopy in patients who have undergone curative

resection of colorectal cancer.¹¹ The current guidelines call for patients to undergo their first surveillance colonoscopy at 1 year after the surgery. If the colonoscopy is normal, the next colonoscopy should be performed after 3 years, and then every 5 years.¹¹ The guidelines of gastroenterology and oncology societies for colorectal cancer surveillance have been changing during the past decade. Table 1 summarizes the guidelines recommended by various societies in the past few years.^{12–14}

Some attention has been paid to underuse of surveillance colonoscopy in the United States.^{15–19} For example, Cooper et al¹⁵ showed that only 73.6% of patients with colorectal cancer who underwent surgery with curative intent received one surveillance colonoscopy within 3 years. By contrast, data on overuse of surveillance colonoscopy are limited. Studying overuse of surveillance colonoscopy is important because colonoscopy is an invasive test with rare but potentially life-threatening complications.^{20–22} Overuse of colonoscopy can lead to increased toxicities without added benefit. Second, colonoscopy is a limited resource, in terms of facilities and practitioners.^{23,24} Identifying and decreasing overuse of surveillance colonoscopy should free up resources for greater use in inadequately screened populations.

The objective of this study was to describe the use patterns of surveillance colonoscopy in Medicare patients who underwent curative resection of colorectal cancer during 1992 to 2005. In this article, we focus on the potential overuse of surveillance colonoscopy in this setting, in particular the use of colonoscopy at shorter intervals than recommended.

Methods

Data Source

We used the Surveillance, Epidemiology and End Results (SEER)–Medicare linked database. The SEER–Medicare data links 2 large population-based sources of detailed information about Medicare beneficiaries with cancer. The data came from the SEER Program of cancer registries that collect clinical, demographic, and cause of death information for persons with cancer and the Medicare claims for covered health care services from the time of a person's Medicare eligibility until death. Since 2000, SEER programs were expanded to 16 registries that represent 28% of the US population.

Abbreviations used in this paper: PCP, primary care providers; SEER, Surveillance, Epidemiology and End Results.

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Study Subjects and Outcome

We formed a cohort of patients aged 66 years and older diagnosed with colorectal cancer during 1992 to 2005. We included those diagnosed with American Joint Committee on Cancer stages 1 to 3 colorectal cancer. Patients with a history of inflammatory bowel disease were excluded. We studied the pattern of receipt of the first 3 colonoscopies after curative surgery in this cohort. To ensure complete information, we excluded patients who were not enrolled in both Medicare Part A and B and were members of a health maintenance organization for the period under observation. In the analyses of surveillance colonoscopy, we limited our study cohorts to patients diagnosed in 1992 to 2003 for the second colonoscopy and in 1992 to 2002 for the third colonoscopy. We examined the indications for colonoscopy using the diagnosis on the colonoscopy claim (provided in the Appendix). We considered the colonoscopies as indicated if the diagnosis was anemia, gastrointestinal bleeding, or other relevant diagnosis such as change in bowel habits, weight loss, abdominal pain, or colostomy problems. If a barium enema or computed tomography of the abdomen or pelvis was performed in the 3 months before the colonoscopy, we also considered the colonoscopy as indicated. A *diagnostic colonoscopy* was defined as one performed to evaluate a clinical indication or performed after radiology. We used the term *surveillance colonoscopy* to refer to procedures performed with no clinical indication or evidence of prior radiology. We used the term *any colonoscopy* to refer collectively to both diagnostic and surveillance colonoscopies.

Table 1 summarizes the guidelines of various authorities of the optimal time between surveillance colonoscopies in patients who had undergone curative resection of colorectal cancer.¹²⁻¹⁴ Some of the recommendations changed during the study period (1992-2005). The minimum duration for the second surveillance colonoscopy in all these guidelines is 3 years after a normal first colonoscopy, and the minimum duration for a third surveillance colonoscopy was 3 to 5 years after a normal second colonoscopy. Hence, we defined any second or third surveillance colonoscopy performed any time from 3 months to 2 years after the previous normal colonoscopy as early surveillance colonoscopy. We defined a normal colonoscopy as one not associated with any procedure such as polyp removal, biopsy, or any other procedure.

Table 1. Guidelines for Duration Between Surveillance Colonoscopy

Society	Recommendation ^a
American Gastroenterological Association (1997)	1 y, then every 3 y
American Society of Clinical Oncology (2000)	Every 3-5 y
American Society of Colon and Rectal Surgeons (2004)	Every 3 y
US Multi-Society Task Force on Colorectal Cancer (2006)	1 y, after 3 y, and then every 5 y

^aIn these recommendations, the intervals between the colonoscopy procedures are based on the assumption that the previous procedure was normal.

Table 2. Characteristics of Patients Who Underwent Curative Surgery for Colorectal Cancer During 1992-2005

Characteristics	Category	N	%
Overall		70,419	100.0
Age, y	67-69	10,754	15.3
	70-74	16,465	23.4
	75-79	17,713	25.2
	≥80	25,487	36.2
Sex	Male	31,895	45.3
	Female	38,524	54.7
Ethnicity	White	59,860	85.0
	Black	4541	6.4
	Hispanic	2663	3.8
	Other	3355	4.8
SEER regions	Connecticut	7178	10.2
	Detroit	7444	10.6
	Hawaii	1213	1.7
	Iowa	8706	12.4
	New Mexico	1867	2.7
	Seattle	4624	6.6
	Utah	1873	2.7
	Atlanta/rural Georgia	2567	3.6
	Kentucky	4015	5.7
	Louisiana	3210	4.6
	New Jersey	8305	11.8
	California	19,417	27.6
Marital status	Married	36,345	51.6
	Not married	34,074	48.4
Census track education (% of adults with <12 y education)	<9.1%	16,246	23.4
	9.1% to <15.3%	17,032	24.5
	15.3% to <23.4%	16,712	24.0
	≥23.4%	19,580	28.1
Census track poverty (% of adults below the poverty line)	<4.1%	15,389	22.1
	4.1% to <7.7%	16,442	23.6
	7.7% to <15.1%	17,168	24.7
Comorbidity	≥15.1%	20,571	29.6
	0	61,982	88.0
	1	5209	7.4
	2	1865	2.6
Year of diagnosis	≥3	1363	1.9
	1992	3839	5.5
	1993	3500	5.0
	1994	3581	5.1
AJCC stage	1995	3421	4.9
	1996	3435	4.9
	1997	3413	4.8
	1998	3569	5.1
	1999	3333	4.7
	2000	7295	10.4
	2001	7247	10.3
	2002	7198	10.2
	2003	7213	10.2
	2004	6774	9.6
	2005	6601	9.4
Grade	1	21,052	29.9
	2	27,680	39.3
	3	21,687	30.8
Well	Well	6604	9.4
	Moderate	47,510	67.5
	Poor	12,678	18.0
	Unknown	3627	5.2

AJCC, American Joint Committee on Cancer.

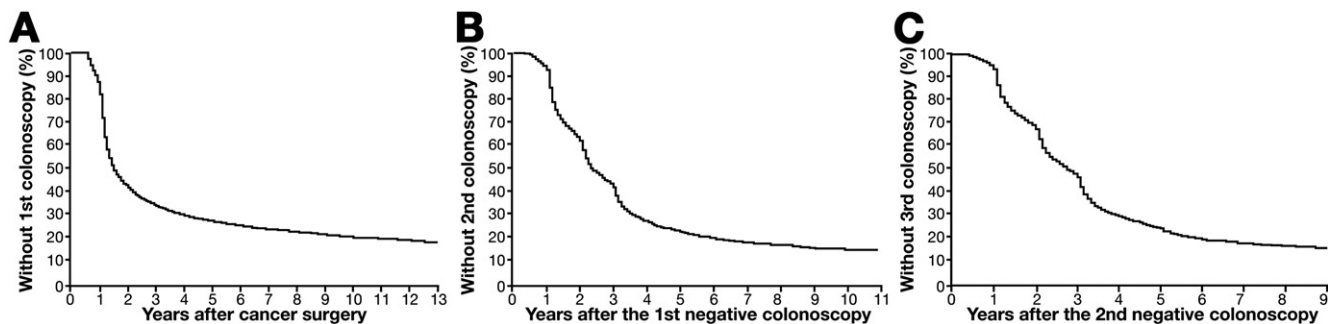


Figure 1. (A) Time of first colonoscopy among patients who underwent curative surgical resection (N = 70,419). This graph includes patients who underwent their first colonoscopy for any indication (either surveillance or diagnostic). The median time between surgery and the first surveillance colonoscopy was 18 months (25th–75th percentile, 13–72 mo). (B) Time of second surveillance colonoscopy after the first normal colonoscopy for 19,969 patients. This graph includes patients who underwent a second colonoscopy for any indication (either surveillance or diagnostic). The median time between the first and second surveillance colonoscopies was 29 months (25th–75th percentile, 16–54 mo). (C) Time of third surveillance colonoscopy after a second normal colonoscopy for 11,666 patients. This graph includes both diagnostic and surveillance colonoscopies. The median time between the second and third surveillance colonoscopies was 33 months (25th–75th percentile, 18–57 mo).

Covariates

Demographic data were collected on age, race, socioeconomic variables, and SEER geographic region. Race was divided into white, black, Hispanic, and other according to the SEER race code classification. For patients diagnosed during 1992 to 1995, education was defined as the proportion of adults who did not complete high school by census tract, based on the 1990 US Census; for patients diagnosed during 1996 to 2002, the 2000 US Census was used. Cancer characteristics were taken from SEER data files. Information was collected on American Joint Committee on Cancer stage (stages 1, 2, and 3) and grade (well, moderately, and poorly differentiated). Comorbidity was assessed using Klabunde’s adaptation of the Charlson comorbidity index.²⁵ Higher scores indicate more comorbidity. This analysis required Medicare inpatient and outpatient claims in the 12 months before the diagnosis of colorectal cancer; therefore, we limited our analysis to subjects aged 66 years and above. Data on physician experience was based on the number of years since their graduation year and was obtained from American Medical Association linkage files. Physician specialty was obtained from Medicare part B claims.

Statistical Analysis

The rate of any colonoscopy after a normal colonoscopy was calculated using the Kaplan–Meier method. Beneficiaries were censored at death, loss of coverage, or end of follow-up period (December 31, 2006). Multivariate analysis of receipt of early surveillance colonoscopy without indications was performed using a modified Poisson regression model. Patients without 2 full years of follow-up evaluation after the first or second colonoscopy were excluded from analyses of early surveillance colonoscopy. All analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC).

Results

Table 2 shows the characteristics of our initial study cohort. We then used the Kaplan–Meier method to estimate time to follow-up colonoscopies. Figure 1A shows the time from surgery to any initial colonoscopy, either diagnostic or surveillance. Similarly, Figure 1B and C show the time to any second and third colonoscopy in patients who underwent a normal first or second colonoscopy, respectively. Two findings

Table 3. Change Over Time in the Intervals Between the First, Second, and Third Colonoscopies During the Study Period

		Year of diagnosis				Log rank <i>P</i> value ^a
Percentile		1992–1994	1995–1997	1998–2000	2001–2003	
Time between first and second colonoscopy, mo	Q1	14 ^b	15 (15–16)	17 (16–18)	19 (18–20)	<.0001
	Q2	26 (25–27)	28 (27–30)	31 (29–32)	32 (30–34)	
	Q3	58 (51–66)	52 (48–57)	53 (50–60)		
Time between second and third colonoscopy, mo	Q1	15 (14–15)	18 (17–20)	23 (21–24)	22 (19–23)	.0106
	Q2	31 (28–33)	36 (34–37)	36 (35–37)	29 (28–32)	
	Q3	60 (55–63)	60 (56–64)	56 (50–61)		

NOTE. The median and 25th and 75th percentiles for months between a first normal colonoscopy after surgery for colorectal cancer and any follow-up colonoscopy are given.

Q, quartile.

^aThe log-rank test assesses the rate of colonoscopy during the entire follow-up period between patients diagnosed during different eras.

^bRequiring weekly data to estimate the 95% confidence interval, the rate of colonoscopy jumped from 21.9% at 13 months to 28.8% at 14 months.

Table 4. Characteristics of Patients Who Underwent a Second or Third Surveillance Colonoscopy Within 2 Years of a Previous Normal Colonoscopy

Characteristics	Category	Patients with normal first colonoscopy			Patients with normal second colonoscopy				
		N	Received second surveillance colonoscopy ^a within 2 y after first normal colonoscopy	P value	N	Received third surveillance colonoscopy ^a within 2 y after second normal colonoscopy	P value		
Overall		14,144 ^b	32.1		8047 ^b	27.3			
Age, y	67–69	1755	45.0	<.0001	546	46.3	<.0001		
	70–74	3775	36.2		2314	30.9			
	75–79	4045	32.3		2515	27.7			
	≥80	4569	23.6		2672	20.0			
Sex	Male	5957	34.2	<.0001	3457	28.7	.0146		
	Female	8187	30.6		4590	26.3			
Ethnicity	White	12,352	32.1	.3008	7046	27.2	.3411		
	Black	819	33.9		418	29.0			
	Hispanic	435	32.2		252	31.0			
	Other	538	29.0		331	24.8			
	SEER regions	Connecticut	1383		31.0	<.0001		821	21.7
	Detroit	1801	42.3	1254	35.9				
	Hawaii	214	26.2	131	19.9				
	Iowa	2408	35.1	1567	28.8				
	New Mexico	343	46.7	241	38.2				
	Seattle	938	16.4	532	13.5				
	Utah	425	33.7	238	28.2				
	Atlanta/rural Georgia	608	28.1	347	22.2				
	Kentucky	784	25.3	307	27.0				
	Louisiana	619	30.4	242	28.9				
	New Jersey	1301	39.1	584	34.9				
	California	3320	28.0	1783	24.0				
Marital status	Married	8090	34.1	<.0001	4856		28.5	.0026	
	Not married	6054	29.5		3191		25.5		
Census tract education (% of adults with <12 y education)	<9.1%	3398	30.1	.0012	1932		25.5	.0023	
	9.1% to <15.3%	3436	31.1		1984	25.4			
	15.3% to <23.4%	3514	34.4		2029	28.3			
	≥23.4%	3625	32.9		1978	30.2			
Census tract below poverty	<4.1%	3178	35.2	.0001	1931	28.5	.6407		
	4.1% to <7.7%	3417	32.3		1962	26.8			
	7.7% to <15.1%	3578	30.0		2057	26.5			
	≥15.1%	3800	31.6		1973	27.6			
Comorbidity	0	10,810	28.9	<.0001	5617	27.3	.0919		
	1	2092	43.3		1621	28.9			
	2	743	43.5		506	25.5			
	≥3	499	37.3		303	22.4			
	Year of diagnosis	1992	988		37.7	<.0001		719	32.1
	1993	870	39.3	646	30.0				
	1994	876	35.8	642	30.5				
	1995	853	39.0	629	25.9				
	1996	839	33.6	689	27.1				
	1997	880	30.1	681	23.9				
	1998	940	33.1	706	23.4				
	1999	887	27.5	578	20.4				
	2000	1913	29.3	1251	23.8				
	2001	1860	30.1	925	27.8				
	2002	1781	28.4	581	39.1				
	2003	1457	31.2						
AJCC stage	1	4762	30.4	.0004	2838	27.0	.0297		
	2	5587	31.9		3147	26.3			
	3	3741	34.5		2035	29.5			
Grade	Well	1361	31.5	.7045	765	25.1	.1824		
	Moderate	9735	32.0		5528	27.9			
	Poor/unknown	2283	32.8		1284	26.3			
Physician specialty ^c	Gastroenterology	6542	29.8	<.0001	3748	25.5	.0041		
	Generalist	987	32.9		594	26.1			
	Surgeon	5703	34.7		3134	29.3			
	Other	317	31.3		187	27.3			

Table 4. Continued

Characteristics	Category	Patients with normal first colonoscopy			Patients with normal second colonoscopy		
		N	Received second surveillance colonoscopy ^a within 2 y after first normal colonoscopy	P value	N	Received third surveillance colonoscopy ^a within 2 y after second normal colonoscopy	P value
Years since graduation of the colonoscopist ^b	<10	536	41.8	<.0001	369	30.4	.5395
	10–19	3921	34.0		2450	26.9	
	20–29	4658	30.6		2625	26.8	
	≥30	2731	30.4		1346	27.1	

NOTE. These analyses were limited to patients with a normal colonoscopy, with at least 2 years of follow-up data after that colonoscopy, to assess receipt of early subsequent surveillance colonoscopy. Surveillance colonoscopy is a colonoscopy lacking a diagnosis, indicating it might have been performed to evaluate a specific symptom.

AJCC, American Joint Committee on Cancer.

^aSurveillance colonoscopy was defined as a colonoscopy with no diagnosis or prior procedure, suggesting it was performed for diagnostic reasons. Among all the patients who underwent a colonoscopy within 2 years after the first and second colonoscopies, diagnostic indication was found in 21% and 23% of patients, respectively.

^bData on year of graduation was missing for 2298 patients (16.3%) and 1257 patients (15.6%) for their first and second colonoscopies, respectively. Specialty and experience were all characteristics of the previous colonoscopy; for example, in the analysis of early second surveillance colonoscopy, these were the characteristics related to first colonoscopy.

^cData on physician specialty was missing for 595 patients (4.2%) and 384 patients (4.8%) for their first and second colonoscopies, respectively.

are apparent. First, approximately 17.5% of patients never undergo a first surveillance colonoscopy, and an additional 14.8% of patients with a normal first colonoscopy do not undergo subsequent colonoscopies. Second, [Figure 1B](#) shows that a substantial proportion of patients undergo follow-up colonoscopy within 2 years after their first normal colonoscopy, with a similar pattern shown in [Figure 1C](#) for patients after their second normal colonoscopy.

The timing of any follow-up colonoscopies changed somewhat over the 1992 to 2002 study period. [Table 3](#) presents the median and 25th and 75th percentiles for months between the first normal colonoscopy and the second colonoscopy for any reason, and also between a second normal colonoscopy and any third colonoscopy. Between cancers initially treated in 1992 to 1994 and 2001 to 2003, there was a significant trend for somewhat longer median times between the first normal colonoscopy and any follow-up colonoscopy, from 26 months in 1992 to 1994 to 32 months in 2001 to 2003. There was no clear temporal pattern of change over time in the interval between the second and third colonoscopies.

To further investigate the potential use of colonoscopy earlier than recommended, we identified patients who received a second colonoscopy within 2 years of a normal first colonoscopy and those who received a third colonoscopy within 2 years of a normal second colonoscopy. Among these, we identified patients with a claim that suggested a diagnostic purpose for the colonoscopy. The remaining patients were considered to have undergone surveillance colonoscopy after a normal prior colonoscopy. [Table 4](#) presents the percentage of patients who had early surveillance colonoscopy, stratified by patient, geographic, and tumor characteristics. Overall, 32.1% of patients with a normal first colonoscopy underwent a second colonoscopy within 2 years for surveillance. Similarly, 27.3% of patients with a second normal colonoscopy underwent a third colonoscopy within 2 years for surveillance. This occurred more often in younger patients, but was still more than 20% for patients aged 80 or older. There were also marked variations among the SEER areas, with Seattle having rates approximately one-third

of those of New Mexico. Patients with a previous colonoscopy by a surgeon or by a more recently trained physician were more likely to undergo a subsequent early surveillance colonoscopy.

[Table 5](#) presents the results of multivariable analyses of odds of receiving an early surveillance colonoscopy. Most of the associations found in the bivariate analyses in [Table 4](#) are maintained. There is a clear decline in older patients, with no association with sex, ethnicity, marital status, or education. There was a temporal decrease in odds of receiving early surveillance between the early 1990s and the 2000s. Tumor stage and grade had a modest or no effect on odds of receiving early surveillance colonoscopy. Surgeons and more recently trained physicians were more likely to be associated with early surveillance colonoscopy.

Discussion

Our study shows that some patients with colorectal cancer who have undergone curative resection undergo surveillance colonoscopy more frequently than recommended by the guidelines, whereas other patients never receive any surveillance colonoscopy. We sought to estimate the magnitude and predictors of overuse of surveillance colonoscopy.

We found that 32% and 27% of patients underwent early second and third surveillance colonoscopy for no clear indication, respectively. This is a conservative estimate because we defined colonoscopy performed within 2 years as early surveillance colonoscopy. The current recommendation by most gastroenterology and oncology societies is to perform a second surveillance at 3 years and a third surveillance colonoscopy at 5 years.^{11,13} Further, we included only patients whose prior colonoscopy was not associated with any additional procedure such as biopsy or polyp removal. The histologic findings in some of these patients undergoing additional procedures would have been nonadenomatous (eg, hyperplastic polyps, normal colon mucosa) requiring no need to shorten the surveillance interval. Of interest, potential clinical indications for more

Table 5. Multivariable Analysis of Patient Characteristics Associated With Odds of Receiving an Early Second or Third Surveillance Colonoscopy Within 2 Years After a Normal Colonoscopy

Characteristics	Category	Second surveillance colonoscopy within 2 y after the first normal colonoscopy ^a		Third surveillance colonoscopy within 2 y after the normal second colonoscopy ^a	
		OR	95% CI	OR	95% CI
Age, y	67–69	1.00		1.00	
	70–74	0.80	(0.73–0.87)	0.69	(0.60–0.80)
	75–79	0.73	(0.67–0.80)	0.63	(0.55–0.73)
	≥80	0.55	(0.50–0.60)	0.47	(0.40–0.54)
Sex	Male	1.00		1.00	
	Female	0.97	(0.91–1.03)	0.96	(0.88–1.05)
Ethnicity	White	1.00		1.00	
	Black	0.95	(0.84–1.09)	0.96	(0.79–1.17)
	Hispanic	0.93	(0.78–1.11)	0.98	(0.77–1.25)
	Other	1.02	(0.85–1.23)	1.08	(0.84–1.40)
SEER regions	Connecticut	1.92	(1.59–2.31)	1.62	(1.23–2.14)
	Detroit	2.45	(2.05–2.92)	2.55	(1.99–3.28)
	Hawaii	1.61	(1.15–2.25)	1.29	(0.79–2.10)
	Iowa	2.09	(1.76–2.49)	2.15	(1.67–2.76)
	New Mexico	2.83	(2.26–3.55)	2.73	(1.99–3.75)
	Seattle	1.00		1.00	
	Utah	2.02	(1.61–2.53)	1.99	(1.43–2.79)
	Atlanta/rural Georgia	1.70	(1.36–2.12)	1.58	(1.15–2.19)
	Kentucky	1.69	(1.35–2.11)	1.93	(1.38–2.71)
	Louisiana	2.02	(1.61–2.52)	1.97	(1.39–2.79)
	New Jersey	2.79	(2.31–3.36)	2.52	(1.89–3.35)
	California	1.84	(1.55–2.19)	1.78	(1.38–2.29)
Marital status	Married	1.06	(0.99–1.13)	1.03	(0.94–1.13)
	Not married	1.00		1.00	
Census tract education (% of adults with <12 y education)	<9.1%	1.00		1.00	
	9.1% to <15.3%	0.99	(0.91–1.09)	0.98	(0.86–1.11)
	15.3% to <23.4%	1.03	(0.94–1.12)	1.03	(0.91–1.17)
	≥23.4%	1.00	(0.91–1.09)	1.08	(0.95–1.24)
Comorbidity	0	1.00		1.00	
	1	1.46	(1.35–1.57)	1.09	(0.98–1.21)
	2	1.49	(1.32–1.67)	0.96	(0.80–1.15)
	≥3	1.29	(1.11–1.50)	0.85	(0.66–1.08)
Year of diagnosis	1992	1.00		1.00	
	1993	1.03	(0.89–1.19)	0.94	(0.77–1.13)
	1994	0.95	(0.82–1.11)	0.98	(0.81–1.18)
	1995	1.04	(0.90–1.21)	0.82	(0.67–1.00)
	1996	0.91	(0.78–1.06)	0.89	(0.74–1.09)
	1997	0.81	(0.69–0.95)	0.78	(0.64–0.96)
	1998	0.89	(0.76–1.04)	0.77	(0.63–0.94)
	1999	0.76	(0.64–0.89)	0.68	(0.55–0.85)
	2000	0.77	(0.67–0.88)	0.74	(0.62–0.89)
	2001	0.77	(0.67–0.88)	0.82	(0.68–1.00)
	2002	0.73	(0.63–0.84)	1.15	(0.95–1.41)
2003	0.80	(0.69–0.92)			
AJCC stage	1	1.00		1.00	
	2	1.05	(0.98–1.13)	0.96	(0.87–1.06)
	3	1.10	(1.02–1.19)	1.06	(0.95–1.18)
Grade	Well	1.00		1.00	
	Moderate	1.03	(0.93–1.14)	1.14	(0.98–1.33)
	Poor/unknown	1.07	(0.94–1.20)	1.09	(0.91–1.31)
Physician specialty	Gastroenterology	1.00		1.00	
	Generalist	1.06	(0.94–1.20)	1.00	(0.84–1.19)
	Surgeon	1.14	(1.07–1.22)	1.10	(0.99–1.21)
	Other	0.96	(0.79–1.17)	0.90	(0.67–1.19)
Years since graduation of the colonoscopist	<10	1.00		1.00	
	10–19	0.83	(0.72–0.96)	0.92	(0.75–1.13)
	20–29	0.77	(0.67–0.89)	0.94	(0.77–1.15)
	≥30	0.77	(0.67–0.90)	0.94	(0.76–1.16)

AJCC, American Joint Committee on Cancer; CI, confidence interval; OR, odds ratio.

^aSurveillance colonoscopy is defined as a colonoscopy with no diagnosis or prior procedure, suggesting it was performed for diagnostic reasons.

frequent surveillance, such as tumor stage or histologic grade, had no or minimal association with receipt of early surveillance.

The underlying reasons for this pattern of overuse probably are related to physician practice patterns and patient demands. There is significant variability in physician recommendations as well as physician adherence to the guidelines for surveillance colonoscopy intervals and follow-up evaluation in colorectal cancer survivors.^{26–28} A survey of colorectal surgeons in the United States on the follow-up evaluation and surveillance of colorectal cancer survivors revealed that only 49% adhered to guidelines. In that study, the surveillance intervals recommended by the surgeons varied from annually (14% of physicians) to once in 5 years (10% of physicians).²⁷ Similar variability exists among the primary care providers (PCPs) and oncologists, who generally comprise the first point of contact for follow-up evaluation of colorectal cancer patients.^{26,28} The awareness of and adherence to the guidelines among PCPs and oncologists plays a very important role in the use pattern of surveillance colonoscopy. Often, the endoscopist does not see the patient in the clinic before performing the colonoscopy. These patients are referred directly for the procedure by either their PCP or oncologist.

Another potential explanation for performance of surveillance colonoscopy at intervals shorter than recommended is imbedded in patient behavior and demands. Colorectal cancer survivor patients may be anxious about tumor recurrence and may request that procedures be performed more frequently than recommended by guidelines.^{29–31}

We observed significant regional variation in the use of early second and third surveillance colonoscopy. Patients in some SEER regions were more than twice as likely to undergo early surveillance colonoscopy than those in other regions. Areas with higher rates of early second surveillance colonoscopy consistently had similarly higher rates of early third surveillance colonoscopy. The regional variation likely is related to variation in practice patterns and health care delivery systems.^{16,32,33}

It is troubling that a significant percentage of patients older than 80 years underwent early surveillance colonoscopy. There are no clear recommendations on the age limit for performance of surveillance colonoscopy after curative colorectal cancer resection. Guidelines from the American Cancer Society and US Multi-Society Task Force on Colorectal Cancer recommend discontinuing surveillance colonoscopy in patients with a life expectancy less than 10 years.¹¹ In this study, we also found that patients with multiple comorbidities had a higher likelihood of receiving an early surveillance colonoscopy with no clear indication. It is unclear why these patients undergo surveillance colonoscopy more often. It may be that patients with multiple comorbidities see multiple medical providers, increasing their risk of being recommended for another surveillance colonoscopy. There was a significant decrease in occurrence of early surveillance colonoscopy during the study period (1992–2003). This was noted for the second surveillance colonoscopy. We analyzed the trend of colonoscopy use over the study period and found a significantly increasing interval (Table 3). This decrease in occurrence of early surveillance colonoscopy may be related to increased awareness among physicians about post-cancer surveillance guidelines. In 1997, Winawer et al¹² published guidelines endorsed by major gastroenterology, surgery, and oncology societies. In these guidelines, the investigators stated there is no evidence to suggest that the rate of progres-

sion of adenomatous polyps to cancer was different among patients who have had cancer from those in average-risk individuals.

In our study we also found underuse of surveillance colonoscopy (Figure 1). Cooper et al^{15,18} and others^{16,17,19} have tried to address the predictors of underuse of surveillance colonoscopy. Decreased rates of surveillance colonoscopy were associated with advanced age, African American race, and multiple comorbidities. It also is likely that the overuse of limited resources may play a role in many patients not receiving the surveillance colonoscopy at the recommended intervals. Our study had several limitations. Some procedures could be performed sooner than recommended by the guidelines owing to suboptimal bowel preparation of the prior examination. Details of the colonoscopy, such as the quality of bowel preparation and the actual procedure findings, were not known from the administrative data. However, to minimize the effect of bowel preparation, we did not include any repeat procedures performed within 3 months of the surgery or prior colonoscopy. The estimates obtained in this study are for the population older than 66 years, and cannot be extrapolated to younger populations.

Our study showed that many patients who underwent curative resection for colorectal cancer receive surveillance colonoscopy sooner than recommended by the guidelines. This study provides an estimate of the magnitude of the overuse and is the first step in evaluating this problem. Future studies are required to further assess the influence of physician practice parameters as well as patient behaviors, which lead to more frequent performance of surveillance colonoscopy than recommended by the guidelines.

Supplementary Material

Note: To access the supplementary material accompanying this article, visit the online version of *Clinical Gastroenterology and Hepatology* at www.cghjournal.org, and at <http://dx.doi.org/10.1016/j.cgh.2012.08.009>.

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Appendix: Codes Used for Receipt of Colonoscopy

Codes for indications for colonoscopy

Anemia (280.0, 280.1, 280.8, 280.9, 281.0, 281.1, 281.2, 281.3, 281.4, 281.8, 281.9, 285.0, 285.1, 285.2, and 285.9)
 Gastrointestinal bleeding (286.5, 459.0, 562.02, 562.03, 562.12, 562.13, 569.3, 569.84, 569.85, 569.86, 578.1, 578.9, 792.1, and 998.11)
 Other related symptoms
 Constipation (560.1, 560.81, 560.89, 560.9, 564.0, 564.00, 564.09, 564.01, and 564.02)
 Diarrhea (008.42, 008.43, 008.45, 008.5, 008.8, 009.0–009.3, 558.1, 558.2, 558.3, 558.9, 564.4, 564.5, 564.7, 564.8, 564.9, 787.91, and 078.5)
 Abdominal pain (789.0, 787.3, 789.4, and 789.6)
 Ischemic bowel disease (557.0, 557.1, and 557.9)
 Irritated bowel syndrome (564.1)
 Bowel habits change (787.99)
 Hemorrhoids (455)
 Weight loss (783.2, 783.0, 780.3, and 783.7)
 Incontinence of feces (787.6)
 Other disorders of intestine (rectal prolapse, anal polyp, and so forth) (569)
 Anal fistula (565)
 Abscess of rectal/anal (566)
 Secondary cancer or suspicion of metastasis (150–2, 155–9, 162–5, 170–6, and 179–199)
 Diverticulitis (562.11)

Other conditions in which a colonoscopy might plausibly be indicated

Protein calorie malnutrition (260–263)
 Radiation colitis (558.1)
 Volvulus (560.2)
 Impaction of intestine (560.30 and 560.39)
 Abnormal radiology of gastrointestinal tract (793)
 Weight loss (783.2, 783.3, and 783.4)
 Stenosis of rectum and anus (569.2)
 Ulcer of anus and rectum (569.41)
 Colostomy problem (569.6, V44.3, V45.3, and V55.3)
 Fistula of intestine (569.81)
 Ulcer of intestine (569.82)
 Intestinovesical fistula (596.1)
 Dermatomyositis (710.3)
 Injury to colon and rectum (863.4)
 Foreign body in colon (936)
 Complications of anastomosis (997.4)
 Surveillance
 Colon cancer (153, 154, 230.3, and 230.4)
 History of colon cancer (V10.05 and V10.06)
 Benign neoplasm of colon/rectal (211.3 and 211.4)
 History of colonic polyps (V12.72)
 Screening of colon cancer (V76.41 and V76.51)
 Family history or gastrointestinal cancer (V16.0)
 Surveillance after surgery, chemotherapy, or radiation (V67.0)
 After care after surgery for neoplasm (V58.42)
 Other specified aftercare after surgery (V58.49 and 58.75)